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[54] METHOD OF MAKING A COMPOSITE MAGNESIUM-TITANIUM CONDUCTOR

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[56] References Cited

UNITED STATES PATENTS

833,290	10/1906	Betts	174/126 CP X
3,364,976	1/1968	Reding	164/63
3,389,460	6/1968	Rubinstein et al.	29/624
3,671,415	6/1972	King et al.	204/284
3,717,929	2/1973	Atkinson et al.	29/624

FOREIGN PATENTS OR APPLICATIONS

448,830	6/1948	Canada	174/126 CP
1,045,966	10/1966	Great Britain	174/126 CP

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[57] ABSTRACT

Method of introducing a molten magnesium base alloy containing at least about 0.05 weight per cent lithium into a hollow titanium body in order to form a composite suitable for use as an electrical conductor.

9 Claims, No Drawings

METHOD OF MAKING A COMPOSITE MAGNESIUM-TITANIUM CONDUCTOR

BACKGROUND OF THE INVENTION

This invention pertains to an electrical conductor and more in particular to a titanium clad magnesium conductor.

It is oftentimes desirable to have an electrical conductor resistant to a corrosive environment. Electrical conductors with a casing of iron, titanium or tantalum and a core of aluminum, copper, sodium, tin or zinc, and methods of making such conductors are described in U.S. Pat. Nos. 3,671,415 and 3,717,929, and British Pat. Nos. 1,045,966 and 1,227,506. It is desired to provide an electrical conductor resistant to the detrimental corrosive effects of, for example, caustic environments.

SUMMARY OF THE INVENTION

A novel electrical conductor suitable for use in corrosive environments and a method of forming such conductor have surprisingly been developed. The method comprises at least partically filling a hollow titanium body with a molten magnesium base alloy containing at least about 0.05 weight per cent lithium by first introducing the molten alloy into the titanium body and then solidifying the molten alloy. The magnesium alloy contacts the inner surface of the titanium body sufficiently to maintain electrical contact between the core and cladding during use. Herein, the term "titanium" includes pure titanium and titanium base alloys.

The magneisum alloy cored-titanium cladded composite is especially suited for use as an electrical conductor in corrosive environments such as those containing a high concentration of an alkali as sodium hydroxide.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The titanium cladded-magnesium alloy composite of the present invention is formed by first melting either alloyed or preferably pure magnesium metal and further alloying the molten metal with about 0.05 to about 10 weight per cent and preferably from about 0.1 to about 5 weight per cent and even more preferably from about 0.1 to about 0.5 weight per cent lithium or melting a pre-alloyed magnesium-lithium alloy and heating the molten metal to a temperature less than that at which substantial loss of magnesium and/or lithium occurs. Preferably the metal is heated to within a temperature range of from about 1,250° F. to about 1,400° F. and preferably about 1,275° F. to about 1,325° F. A hollow titanium body, such as a rectangular or circular cylinder pipe or tube, is at least partially and preferably substantially entirely filled with the molten magnesium-lithium alloy. Such filling can be carried out by, for example, pouring the molten metal into the titanium tube. However, it is preferred to employ a titanium tube having one end thereof sealed by, for example, welding and immersing at least the open end of the tube in the molten magnesium-lithium alloy. By means as generally described in U.S. Pat. No. 3,364,976, gases within the tube react with the molten magnesium to thereby cause filling of the tube with the molten metal.

The surface of the titanium in contact with the molten magnesium is generally cleaned to remove at least any excess grease and oil present. Preferably substantially all of the organic contaminants are removed by well known means prior to filling or casting the titanium tube with the molten magnesium. The inner surface of the tube can be further cleaned by known mechanical or chemical means to remove surface oxide before casting.

It has been surprisingly found that the use of an effective amount of lithium in a magnesium alloy enhances the electrical contact between the titanium overcoating or cladding and the magnesium alloy to thereby form a composite having both satisfactory physical properties and electrical conductivity for use as an electrical conductor in, for example, chlorine and sodium hydroxide producing electrolytic cells. The composite of the present invention is also suitable for use as a substrate for a dimensionally stable electrode in, for example, chloralkali electrolytic cells.

The metals described herein are preferably the pure metals containing the impurities normally associated with the commercially obtainable metals. Preferably the magnesium-lithium core alloy has a composition consisting essentially of at least about 90 weight per cent and preferably at least about 99 weight per cent magnesium together with lithium within the above described composition ranges.

The following examples further illustrate the invention:

Examples 1–13

Magnesium with a minimum purity of 99.80 weight per cent was melted in an appropriate container and heated to 1,300° F. A standard flux cover was used to minimize oxidation of the magnesium. Sufficient metallic lithium was added to and mixed with the molten magnesium to form magnesium base alloys containing 0.05, 0.1, 0.5 and 5 weight per cent lithium. The Mg-Li alloys were maintained at a temperature of 1,300° F.

Commercially pure titanium tubes with an outside diameter of one-half inch, a wall thickness of 0.02 inch and one end welded closed were cleaned by washing with acetone. The cleaned tubes were then immersed (open end downwardly positioned) in a bath of the molten Mg-Li alloy for 5, 10 or 30 minute periods to substantially entirely fill the tubes with the Mg-Li alloy.

The alloy filled tubes were slowly removed from the molten alloy bath to solidify the Mg-Li alloy within the titanium tubes to thereby form titanium clad-Mg-Li alloy composites.

The voltage drop across a 6 inch length of the composite was determined at room temperature by electrically connecting a 15 ampere source to each composite and measuring the voltage drop by standard means. Table I contains data obtained during the above described tests. This data confirms that the titanium clad-Mg-Li alloy composite has a low voltage decrease over a unit length and is suitable as an electrical conductor.

Table I

Example	Li (Wt.%)	Time tube in molten metal (minutes)	Voltage drop in 6 inch length (millivolts)
1	0.05	30	2.5
2	0.1	5	0.88
3	0.1	10	0.8
4	0.1	30	1.0
5	0.1	30	0.9
6	0.1	30	0.85
7	0.1	30	0.9
8	0.1	30	0.7
9	0.5	30	0.8
10	0.5	30	1.0
11	5	30	1.1
12	5	30	1.4
13	5	30	1.15

Examples 14 and 15

The composite of Examples 4 and 9 were heated to and maintained at a temperature of 850° F. for one hour and then air cooled. It was determined that the voltage decrease in a 6 inch length of the composite was not altered from that shown in Table I for Examples 4 and 5.

Comparative Examples A and B

Two titanium tubes were filled with 99.8 weight per cent pure magnesium substantially as described for Examples 1–13. The voltage drop across a 6 inch length of the solidified titanium-Mg composite was determined (as in Examples 1–13) to be 18 and 1.1 millivolts. Examples A and B confirm that consistently low voltage drops were not obtained with composites using pure magnesium as a core material.

Composites with a titanium alloy cladding and a magnesium-10 weight per cent lithium alloy core with acceptable properties are produced in accord with the procedure of Examples 1–13. In a manner as described for Examples 1–13 composites with acceptable properties are produced using molten metal temperatures of 1,250° and 1,400° F.

I claim:

1. A method of making a titanium clad magnesium base alloy composite comprising at least partially filling a hollow titanium body with a molten magnesium base alloy containing at least about 0.05 weight per cent lithium and then solidifying the molten alloy to form a composite.

2. The method of claim **1** including heating the molten alloy to within the temperature range of from about 1,250° F. to about 1,400° F. before the filling step.

3. The method of claim **1** including filling a hollow titanium body, having one end enclosed, by immersing an open end portion of the body in the molten magnesium base alloy to permit the reaction between reactive gases within the body with the magnesium to thereby cause filling of the body with the molten magnesium alloy.

4. The method of claim **1** wherein the magnesium base alloy consists essentially of from about 0.05 to about 10 weight per cent lithium and the balance magnesium.

5. The method of claim **1** wherein the magnesium base alloy consists essentially of from about 0.1 to about 5 weight per cent lithium and the balance magnesium.

6. A method comprising providing a molten magnesium base alloy bath consisting essentially of about 0.05 to about 10 weight per cent lithium within a temperature range of from about 1,250° F. to about 1,400° F. and then introducing the molten alloy into a hollow titanium body by immersing at least an open end portion of the body in the molten magnesium alloy to permit reaction between reactive gases in the body with the magnesium to thereby cause filling of the body with the molten magnesium base alloy, and then cooling the magnesium base alloy filled titanium body sufficiently to cause solidification of the molt magnesium base alloy thereby to form a titanium cladded-magnesium base alloy cored composite suited for use as an electrical conductor.

7. The method of claim **6** wherein the titanium body is filled with the molten magnesium alloy.

8. The method of claim **6** wherein the magnesium base alloy contains about 0.1 to about 5 weight per cent lithium.

9. The method of claim **6** wherein the magnesium base alloy contains about 0.1 to about 0.5 weight per cent lithium.

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